

Serial Number: 09/751614

Filing Date: December 29, 2000

Title: VIA-IN-PAD WITH OFF-CENTER GEOMETRY AND METHODS OF MANUFACTURE

Amendments to the Specification

Applicants have carefully reviewed the entire specification for accuracy and consistency of terminology and grammar. On page 1, the status of the “related application” has been updated.

On page 10, the written description has been conformed to FIG. 5 of the drawings by describing the edges 138 and 139 of lands 130 and 131, respectively, as defining a substantially circular perimeter.

On page 12, reference number 117 has been substituted for 119.

In addition, Applicants have made several amendments to the specification by substituting “embodiments of the invention”, “subject matter”, or “disclosure” for “invention”, and by deleting the word “invention” from various sub-titles. This is because Applicants do not wish the claims to be interpreted as being limited to a single “invention”.

No new matter has been added by way of these amendments to the specification.

Amendments to Claims 18-19, 21, 30, 32, 35, 37-38, and 43

Each of original claims 18-19, 21, 30, 32, 35, 37-38, and 43 has been amended. No new matter has been introduced.

In independent claim 18, language has been added to recite that each land has a “substantially circular perimeter”. Support may be found in the original disclosure, for example in FIGS. 5 and 9.

In dependent claim 19, the language “wherein each land has an edge” has been deleted, and the word “perimeter” has been substituted for “edge”.

In independent claim 21, the language “extending into the substrate” has been added. Support may be found in the original disclosure, for example in FIGS. 4 and 6-8.

In dependent claim 30, the claim dependency has been changed from claim 29 to claim 28.

In dependent claim 32, the word “within” has been substituted for “to”.

In dependent claim 35, the language “wherein each land has an edge” has been added. Support may be found in original claim 19, for example.

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In independent claim 37, the language “wherein at least the contacts or the lands are coated with solder” has been added (support may be found on page 11, line 26 through page 12, line 14); the language “substantially circular perimeter and a” has been added (support may be found in FIGS. 5 and 9); the language “and an edge” has been deleted; the language “extending into the substrate” has been added (support may be found in FIGS. 4 and 6-8); the language “perimeter” has been substituted for “edge”; and the language “wherein the geometric centers of vias of the first group of lands are offset in a first direction and the geometric centers of vias of the second group of lands are offset in a second direction” has been deleted.

In dependent claim 38, the language “wherein the contacts and the lands comprise a coating of solder and” has been deleted.

In independent claim 43, the language “substantially circular perimeter and a” has been added; the language “and an edge” has been deleted; the language “extending into the substrate” has been added; the language “perimeter” has been substituted for “edge”; and the language “wherein the geometric centers of vias of the first group of lands are offset in a first direction and the geometric centers of vias of the second group of lands are offset in a second direction” has been deleted. Support for the added language may be found as indicated for independent claim 37 above.

The amendments to the claims are made to satisfy Applicants’ preferences, not necessarily to satisfy any legal requirement(s) of the patent laws, and they are not intended to limit the scope of equivalents to which any claim element may be entitled.

The amendments to the claims are made for the purpose of clarification, and they are not intended to limit the scope of equivalents to which any claim element may be entitled.

New Claims 46-47

New dependent claims 46 and 47 have been added to provide Applicants with additional protection to which Applicants are entitled. No new matter has been introduced.

Dependent claim 46 recites language that was deleted from independent claim 37, as amended herein, namely that the geometric centers of vias of the first group of lands are offset in the first direction and the geometric centers of vias of the second group of lands are offset in the second direction.

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Dependent claim 47 recites language that was deleted from independent claim 43, as amended herein, namely that the geometric centers of vias of the first group of lands are offset in the first direction and the geometric centers of vias of the second group of lands are offset in the second direction.

Claim Objections

Claim 29 was objected to under 37 CFR 1.75(c) as being of improper dependent form for failing to further limit the subject matter of a previous claim. Claim 29 is now canceled.

Claim 32 was also objected to. Claim 32 has been amended to recite that each solder ball adheres to the entire respective land within the perimeter of such land.

Rejection of Claims 22-24 and 39-41 under §112, First Paragraph

Claims 22-24 and 39-41 were rejected under 35 USC §112, first paragraph. The Examiner stated that these claims contained subject matter which was not described in the specification in such a way as to enable one skilled in the art to which it pertains, or with which it is most nearly connected, to make and/or use the invention.

The Examiner stated that claim 21 recites that “each land has a via therein”, and that it was not clear from the specification or the drawings how the via, which is inside the land, has a “thermally expansive substance” residing inside. Claim 21 has been amended to recite “each land having a via therein extending into the substrate”. As shown, for example, in FIG. 6, and discussed on page 11, lines 21-25, via fill 114 may reside within vias 115.

The Examiner stated that claim 37 recites that “each land has a via offset therein”, and that it was not clear from the specification or the drawings how the via, which is inside the land, has a “thermally expansive substance” residing inside. Claim 37 has been amended to recite “each land having a via offset therein extending into the substrate”, similar to the amendment to claim 21 mentioned above.

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**Rejection of Claims 21-25, 27, 35, and 37-42
under §112, Second Paragraph**

Claims 21-25, 27, 35, and 37-42 were rejected under 35 USC §112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which Applicant regards as the invention.

The Examiner stated that claim 21 omitted essential structural relationships of elements, such as how the via is located with respect to the substrate. As mentioned above, claim 21 has been amended to recite “each land having a via therein extending into the substrate”.

The Examiner further stated that claim 35 lacked antecedent basis for “the edge of its associated land”. Claim 35 has been amended to recite that each land has an edge.

The Examiner further stated that claim 37 omitted essential structural relationships of elements, such as how the integrated circuit package is attached to the substrate, and how the via is located with respect to the substrate. Claim 37 has been amended to recite that at least the contacts or the lands are coated with solder, and that each land has a via therein extending into the substrate.

The Examiner further stated that claim 38 is not clear as to how the contacts and the lands comprise a coating of solder. As mentioned above, claim 37, on which claim 38 is dependent, has been amended to recite that at least the contacts or the lands are coated with solder. That is, the contacts and/or the lands may be coated with solder.

**Rejection of Claims 37-38, 43, and 45
under §102(b) as anticipated by Sherman**

Claims 37, 38, 43, and 45 were rejected under 35 USC § 102(b) as being anticipated by Sherman (U.S. Patent No. 5,784,262).

Sherman discloses an arrangement of pad-through-hole combinations (21A, FIG. 2A) on a substrate. Each pad-through-hole combination includes a mounting pad 18A connected to a via pad 26A through a narrow neck-like structure or trace 27A. FIG. 3 shows an arrangement of

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pad-through-hole combinations, in which groups of pad-through-hole combinations are oriented in different directions. In Sherman, the pad-through-hole combination has a dumb-bell shape.

By contrast, independent claims 37 and 43, as amended, recite *inter alia* that each land has a substantially circular perimeter. The structure recited in independent claims 37 and 43 is different from that disclosed in Sherman and provides a potentially more dense arrangement of lands.

For the above reasons, independent claims 37 and 43 should be found to be allowable over Sherman, and Applicants respectfully request that the rejection of claims 37 and 43 under 35 U.S.C. §102(b) as anticipated by Sherman be withdrawn.

Claims 38 and 45, which depend from claims 37 and 43, respectively, and incorporate all of the limitations therein, are also asserted to be allowable for the reasons presented above.

Rejection of Claims 18-20 and 34-36
under §103(a) as unpatentable
over Sherman in view of Perfecto

Claims 18-20 and 34-36 were rejected under 35 USC § 103(a) as being unpatentable over Sherman (U.S. Patent No. 5,784,262) in view of Perfecto et al. (U.S. Patent No. 5,464,682).

Sherman was discussed above.

Perfecto discloses a ceramic substrate (20, FIG. 2) having a circular pad 30. The pad 30 connects a ceramic via 22 with a thin film stud contact portion 28. Perfecto apparently contains no disclosure concerning how a chip (16, FIG. 1) is connected to substrate 20. No disclosure could be found in Perfecto as to a solder ball adhering to a respective one of the pads 30.

Regarding independent claims 18 and 34, the Examiner stated that it would have been obvious to one of ordinary skill in the art to combine the teachings of Sherman and Perfecto in order to have the Sherman land with the same shape as the Perfecto land, in such a way that each solder ball can adhere to the entire land.

Independent claim 18, as amended, is directed to structure that is not disclosed in either Sherman or Perfecto. For example, claim 18 recites *inter alia* a plurality of lands each having a substantially circular perimeter, and a plurality of solder balls, each solder ball adhering to a respective one of the lands, each solder ball adhering to the entire respective land.

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Independent claim 34 recites *inter alia* a substrate comprising a plurality of solder balls, each solder ball adhering to a respective one of the lands, each solder ball adhering to the entire respective land without any material intervening between the solder ball and the respective land.

Because Perfecto fails to disclose any solder ball adhering to circular pad 30, let alone to the entire pad 30, motivation is lacking for substituting the circular pads 30 of Perfecto for the dumb-bell shaped pads of Sherman. Moreover, Applicants respectfully assert that the suggested combination of Sherman and Perfecto is based upon hindsight and would not have been suggested but for Applicants' own disclosure.

For the above reasons, independent claims 18 and 34 should be found to be allowable over any combination of Sherman and Perfecto, and Applicants respectfully request that the rejection of claims 18 and 34 under 35 U.S.C. §103(a) as unpatentable over Sherman in view of Perfecto be withdrawn.

Claims 19-20 and claims 35-36, which depend directly or indirectly from claims 18 and 34, respectively, and incorporate all of the limitations therein, are also asserted to be allowable for the reasons presented above.

Rejection of Claims 21, 25, and 27-30
under §103(a) as unpatentable
over Sherman in view of Perfecto

Claims 21, 25, and 27-30 were rejected under 35 USC § 103(a) as being unpatentable over Sherman (U.S. Patent No. 5,784,262) in view of Perfecto et al. (U.S. Patent No. 5,464,682).

Sherman and Perfecto were discussed above.

Regarding independent claims 21 and 28, the Examiner stated that it would have been obvious to one of ordinary skill in the art to combine the teachings of Sherman and Perfecto in order to have the Sherman land with the same shape as the Perfecto land, in such a way that the solder balls are contacting substantially the entire respective land and to the edge of such land.

Independent claim 21, as amended, recites *inter alia* a substrate having a plurality of lands, each having an edge, and a plurality of solder balls, each solder ball contacting substantially the entire respective land to the edge of the land.

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Independent claim 28 recites *inter alia* a substrate having a plurality of lands, each having an edge, and a plurality of solder balls, each solder ball adhering to a respective one of the lands, each solder ball contacting substantially the entire respective land to the edge of the land.

Because Perfecto fails to disclose any solder ball adhering to circular pad 30, let alone to the entire pad 30, motivation is lacking for substituting the circular pads 30 of Perfecto for the dumb-bell shaped pads of Sherman. Moreover, Applicants respectfully assert that the suggested combination of Sherman and Perfecto is based upon hindsight and would not have been suggested but for Applicants' own disclosure.

For the above reasons, independent claims 21 and 28 should be found to be allowable over any combination of Sherman and Perfecto, and Applicants respectfully request that the rejection of claims 21 and 28 under 35 U.S.C. §103(a) as unpatentable over Sherman in view of Perfecto be withdrawn.

Claims 25 and 27, which depend from claim 21, and incorporate all of the limitations therein, are also asserted to be allowable for the reasons presented above.

Claim 30, which depends from claim 28, and incorporates all of the limitations therein, is also asserted to be allowable for the reasons presented above.

Rejection of Claims 22-24
under §103(a) as unpatentable
over Sherman in view of Perfecto and
further in view of Mehr

Claims 22-24 were rejected under 35 USC § 103(a) as being unpatentable over Sherman (U.S. Patent No. 5,784,262) in view of Perfecto et al. (U.S. Patent No. 5,464,682) and further in view of Mehr (U.S. Patent No. 5,936,848).

Sherman and Perfecto were discussed earlier.

Mehr discloses an electronics package that includes a substrate, a via, and a solder ball. As seen in FIG. 3 of the Mehr patent, solder mask material 38 partially enters into the via 32.

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The Examiner stated that it would have been obvious to one of ordinary skill in the art to further modify the combination of Sherman and Perfecto with Mehr, in order to have a thermally expansive substance (i.e. solder mask material 38) residing in the vias.

Claims 22-24 are dependent, directly or indirectly, from independent claim 21, which Applicants assert to be patentable over the Examiner's suggested combination of Sherman and Perfecto, as set forth earlier. Applicants respectfully assert that the Examiner's suggested combination of Sherman and Perfecto still fails to disclose the specific structure recited in independent claim 21, whether or not solder mask material is present within the vias of Sherman and/or Perfecto.

For this reason, independent claim 21 should be found to be allowable over any combination of Sherman, Perfecto, and Mehr. Likewise, claims 22-24, which depend directly or indirectly from claim 21, and incorporate all of the limitations therein, are also asserted to be allowable for the reasons presented above.

Applicants respectfully request that the rejection of claims 22-24 under 35 U.S.C. §103(a) as unpatentable over Sherman in view of Perfecto and further in view of Mehr be withdrawn.

Rejection of Claims 31-33
under §103(a) as unpatentable
over Sherman in view of Perfecto and
further in view of Sakemi

Claims 31-33 were rejected under 35 USC § 103(a) as being unpatentable over Sherman (U.S. Patent No. 5,784,262) in view of Perfecto et al. (U.S. Patent No. 5,464,682) and further in view of Sakemi et al. (U.S. Patent No. 5,489,750).

Sherman and Perfecto were discussed above.

Sakemi discloses a method of mounting an electronic part with bumps on a circuit board (FIG. 8, described in col. 4, line 66 through col. 5, line 3).

The Examiner stated that it would have been obvious to one of ordinary skill in the art to further modify the combination of Sherman and Perfecto with Sakemi, in order to have each solder ball covering the entire respective land, including the perimeter of such land.

Claims 31-33 are dependent from independent claim 18, which Applicants assert to be patentable over the Examiner's suggested combination of Sherman and Perfecto, as set forth

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earlier. Applicants respectfully assert that the Examiner's suggested combination of Sherman and Perfecto still fails to disclose the specific structure recited in independent claim 18, whether or not the solder ball covers the entire land, including the perimeter of the land. Also, Applicants respectfully assert that the suggested combination of Sherman, Perfecto, and Sakemi is based upon hindsight and would not have been suggested but for Applicants' own disclosure.

For this reason, independent claim 18 should be found to be allowable over any combination of Sherman, Perfecto, and Sakemi. Likewise, claims 31-33, which depend from claim 18, and incorporate all of the limitations therein, are also asserted to be allowable for the reasons presented above.

Applicants respectfully request that the rejection of claims 31-33 under 35 U.S.C. §103(a) as unpatentable over Sherman in view of Perfecto and further in view of Sakemi be withdrawn.

**Rejection of Claims 39-41
under §103(a) as unpatentable
over Sherman in view of Mehr**

Claims 39-41 were rejected under 35 USC § 103(a) as being unpatentable over Sherman (U.S. Patent No. 5,784,262) in view of Mehr et al. (U.S. Patent No. 5,936,848).

Sherman and Mehr were discussed above.

The Examiner stated that it would have been obvious to one of ordinary skill in the art to further modify the combination of Sherman and Perfecto [sic] with Mehr, in order to have a thermally expansive substance (i.e. solder mask material 38) residing in the vias.

Claims 39-41 are dependent directly or indirectly from independent claim 37, which Applicants assert to be patentable over Sherman, as set forth earlier. Applicants respectfully assert that the Examiner's suggested combination of Sherman and Mehr still fails to disclose the specific structure (*inter alia*, each land having a substantially circular perimeter) recited in independent claim 37, whether or not solder mask material is present within the vias of Sherman. Also, Applicants respectfully assert that the suggested combination of Sherman and Mehr is based upon hindsight and would not have been suggested but for Applicants' own disclosure.

For this reason, independent claim 37 should be found to be allowable over any combination of Sherman and Mehr. Likewise, claims 39-41, which depend from claim 37, and

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incorporate all of the limitations therein, are also asserted to be allowable for the reasons presented above.

Applicants respectfully request that the rejection of claims 39-41 under 35 U.S.C. §103(a) as unpatentable over Sherman in view of Mehr be withdrawn.

**Rejection of Claims 42 and 44
under §103(a) as unpatentable
over Sherman in view of Perfecto**

Claims 42 and 44 were rejected under 35 USC § 103(a) as being unpatentable over Sherman (U.S. Patent No. 5,784,262) in view of Perfecto et al. (U.S. Patent No. 5,464,682).

The Examiner stated that it would have been obvious to one of ordinary skill in the art to combine the teachings of Sherman and Perfecto in order to have a circular land.

Claim 42 is dependent from independent claim 37, which Applicants assert to be patentable over Sherman, as set forth earlier. Applicants respectfully assert the Examiner's suggested combination of Sherman and Perfecto does not establish a prima facie obviousness rejection of independent claim 37, as amended. There is no suggestion or motivation in either reference to combine them as suggested by the Examiner.

Sherman discloses a pad-through-hole combination having a dumb-bell shape. A mounting pad portion (18A, FIG. 1) of the pad-through-hole combination (21A', FIG. 2A) is connected to a lead (14A, FIG. 1) by solder (16A, FIG. 1). Sherman contains no suggestion or motivation for substituting a circular pad for a dumb-bell shaped pad-through-hole combination.

Perfecto discloses a circular capture pad (30, FIG. 2) to electrically connect a ceramic via 22 and a thin film stud 24 (col. 3, lines 49-57). However, Perfecto doesn't appear to disclose coupling contacts of an integrated circuit package to the capture pad using solder. Nor does Perfecto appear to disclose that the circular capture pad 30 contains a via therein extending into the substrate, because ceramic via 22 is shown in dashed lines in FIG. 2 and presumably underlies but does not extend into circular capture pad 30. Thus, Perfecto contains no suggestion or motivation for substituting its circular capture pad for the dumb-bell shaped pad-through-hole combination of Sherman.

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In addition, Applicants respectfully assert that the Examiner's suggested combination of Sherman and Perfecto is based upon hindsight and would not have been suggested but for Applicants' own disclosure.

For this reason, independent claim 37 should be found to be allowable over any combination of Sherman and Perfecto. Likewise, claim 42, which depends from claim 37, and incorporates all of the limitations therein, is also asserted to be allowable for the reasons presented above. Applicants respectfully request that the rejection of claim 42 under 35 U.S.C. §103(a) as unpatentable over Sherman in view of Perfecto be withdrawn.

Claim 44 is dependent from independent claim 43, which Applicants assert to be patentable over Sherman, as set forth earlier. Applicants respectfully assert the Examiner's suggested combination of Sherman and Perfecto does not establish a *prima facie* obviousness rejection of independent claim 43, as amended. There is no suggestion or motivation in either reference to combine them as suggested by the Examiner. Sherman contains no suggestion or motivation for substituting a circular pad for a dumb-bell shaped pad-through-hole combination. Perfecto contains no suggestion or motivation for substituting its circular capture pad for the dumb-bell shaped pad-through-hole combination of Sherman. Moreover, Applicants respectfully assert that the Examiner's suggested combination of Sherman and Perfecto is based upon hindsight and would not have been suggested but for Applicants' own disclosure.

For this reason, independent claim 43 should be found to be allowable over any combination of Sherman and Perfecto. Likewise, claim 44, which depends from claim 43, and incorporates all of the limitations therein, is also asserted to be allowable for the reasons presented above. Applicants respectfully request that the rejection of claim 44 under 35 U.S.C. §103(a) as unpatentable over Sherman in view of Perfecto be withdrawn.

Additional Elements and Limitations

Applicants consider additional elements and limitations of claims 18-25, 27-28, 30-43, and 45-47 to further distinguish over the cited references, and Applicants reserve the right to present arguments to this effect at a later date.

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Documents Cited But Not Relied Upon For This Office Action

Applicants need not respond to the assertion of pertinence stated for the references cited but not relied upon by the Office Action, because these references are not made part of the rejections in this Office Action. Applicants are expressly not admitting to this assertion and reserve the right to address the assertion should it form part of future rejections.

Conclusion

Applicants respectfully submit that claims 18-25, 27-28, 30-43, and 45-47 are in condition for allowance, and notification to that effect is earnestly requested. The Examiner is invited to telephone Applicants' attorney Walter W Nielsen at 602-298-8920 or the below signed attorney to facilitate prosecution of this application.

If necessary, please charge any additional fees or credit overpayment to Deposit Account No. 19-0743.

Respectfully submitted,

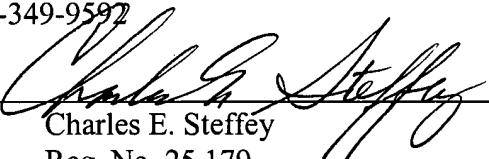
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CERTIFICATE UNDER 37 CFR 1.8: The undersigned hereby certifies that this correspondence is being deposited with the United States Postal Service with sufficient postage as first class mail, in an envelope addressed to: Commissioner of Patents, Box AF, Washington, D.C. 20231, on this 4th day of February, 2003.

Dawn M. Lohr
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